

# APPROVAL SHEET FOR SUSPENDED LOAD OPERATIONS

SLO-KSC-1991-012

TITLE Aft Booster Set Down on the Aft Booster  
Transportation Pallet Support Post Ball Fittings

DOCUMENT NUMBER/TITLE OMI 05309 - Aft Booster Assembly - RPSF

PREPARED BY Malcolm Colenin

DATE 2/18/99

## REQUIRED APPROVAL

CONTRACTOR \_\_\_\_\_ DESIGN \_\_\_\_\_ R & QA \_\_\_\_\_ OPERATIONS \_\_\_\_\_ SAFETY  
 NASA \_\_\_\_\_ DESIGN \_\_\_\_\_ R & QA \_\_\_\_\_ OPERATIONS \_\_\_\_\_ SAFETY

TYPE OR PRINT NAME	SIGNATURE	ORGN.	DATE
Malcolm Colenin	<i>Malcolm Colenin</i>	EI-C-A	2/18/99
LLOYD EDGECOMB	<i>Lloyd Edcomb</i>	USA 5532	3/17/99
WALTER ROYTER	<i>Walter Royter</i>	PH-H	4/26/99
JOHN W. GARRETT	<i>John W. Garrett</i>	USA 5451	4/28/99
Alfred M. Stevens	<i>Alfred M. Stevens</i>	USA 5452	4/30/99

CONTRACTOR DIRECTOR OF SAFETY



**NASA SUSPENDED LOAD OPERATION  
ANALYSIS/APPROVAL (SLOAA)**

**SLO-KSC-1991-012  
CHANGE 1, FEBRUARY 1999  
PAGE 1 OF 5**

**OPERATION:** Aft Booster Set Down on the Aft Booster Transportation Pallet Support Post Ball Fittings

**SUPPORTING DOCUMENTS:** The associated operational procedure/systems assurance analyses are as follows:

1. OMI B5309, Aft Booster Assembly - RPSF.
2. SAA09FY112-002, System Assurance Analysis of the 200-Ton Main/15-Ton Auxiliary Bridge Cranes at the SRB Rotation/Processing Facility.

**GENERAL DESCRIPTION:** Four personnel are required to be directly under the suspended aft booster assembly during aft booster positioning on the aft booster transportation pallet posts. Operations include the following:

- Clean, inspect, and repair the aft skirt shoe sockets.
- Align aft skirt shoes during set down operations.

The aft booster is connected to the H77-0384-1 or the H77-0388 lifting beam. The lifting beam is connected to the 200 ton bridge crane in the Rotation, Processing and Surge Facility (RPSF).

The aft booster is raised off the facility buildup stand post ball fittings approximately 2-3 feet. The aft skirt shoe sockets are then cleaned, inspected/repared. The aft booster is held stationary until personnel can man-up on the transportation pallet. The cleaning, inspection/repair requires four personnel to be directly under the suspended aft booster.

The aft booster is then lifted out of the facility buildup stand and transferred to the transportation pallet where it is aligned and positioned onto the posts of the pallet. The alignment and positioning of the aft booster onto the transportation pallet posts requires four personnel to be directly under the suspended aft booster.

**RATIONALE/ANALYSIS:** The suspended load tasks comply with the NASA Alternate Safety Standard for Suspended Load Operations as follows:

**Alternate Standard Requirement #1a:** The operation cannot be performed without personnel beneath the suspended load because there are no operational means of performing the booster inspections and alignment without risking damage to flight hardware. By physically positioning a person under the aft booster shoe, clearances required in the alignment are maintained. Design



**NASA SUSPENDED LOAD OPERATION  
ANALYSIS/APPROVAL (SLOAA)**

**SLO-KSC-1991-012  
CHANGE 1, FEBRUARY 1999  
PAGE 2 OF 5**

options to build an alignment tool increased the hazards associated with working under a suspended aft booster segment. The alignment tool would introduce a new suspended load operation. The procedures have been modified to minimize the exposure time and number of personnel exposed to the suspended load hazard.

An inspection shoe adapter to perform inspections while supporting the aft booster assembly over the transportation pallet was investigated. The shoe adapter was determined to be unstable for protecting personnel under a suspended load. The adapter would have to be bolted to the support post ball fittings on the transportation pallet. The clearances required to prevent damage to the exit cone (approximately 6 feet above the floor of the transfer aisle to allow for nozzle clearance) prohibit the use of dunnage or any other stand. The proposed adapters, which would weigh a minimum of 400 lbs each, would require the assistance of a hoist or a mobile crane for installation on the transportation pallet. Installation of these adapters would be a suspended load operation.

No other tooling is available or feasible to support the weight of the entire aft booster assembly should a crane or lifting beam failure occur.

**Alternate Standard Requirement #1b:** Secondary support systems to assume support of (catch) the load were evaluated and were not feasible for this operation; see Alternate Standard Requirement #1a.

**Alternate Standard Requirement #1c:** The maximum number of personnel allowed under the suspended booster at any one time during aft booster alignment is four. One person is required under each post during the alignment operation.

The maximum number of personnel under the suspended booster at any one time during aft booster shoe inspection and dry-lube repair is four; at each shoe.

**Alternate Standard Requirement #1d:** Personnel will accomplish the required suspended load tasks as quickly and safely as possible to minimize time exposure. Total exposure time is approximately 30 minutes for alignment/positioning and 30 minutes per shoe for inspection and repair.

**Alternate Standard Requirement #2:** Suspended load operations are reviewed and approved on a case-by-case/specific need basis - see General Description and Alternate Standard Requirement #1.



**NASA SUSPENDED LOAD OPERATION  
ANALYSIS/APPROVAL (SLOAA)**

**SLO-KSC-1991-012  
CHANGE 1, FEBRUARY 1999  
PAGE 3 OF 5**

**Alternate Standard Requirement #3:** Only those suspended load operations approved by the Center NASA Safety Assurance Director will be permitted. A list of approved suspended load operations will be maintained by the Center NASA Safety Assurance Directorate.

**Alternate Standard Requirement #4:** OMI B5309 is written to allow only required personnel under the suspended load. The OMI is available on site during the operation.

**Alternate Standard Requirement #5:** A new suspended load operation not covered by this SLOAA, deemed necessary due to unusual or unforeseen circumstances where real time action is required, shall be documented and approved by the Center NASA Safety Assurance Director.

**Alternate Standard Requirement #6:** Suspended load operations in the RPSF associated with lifting motor segments involve the use of one of the 200 ton bridge cranes and one of two lifting beams. The cranes are designed, tested, inspected, maintained, and operated in accordance with the NASA Safety Standard for Lifting Devices and Equipment, NSS/GO-1740.9. The cranes are designed with a minimum safety factor of 5 (based on the ultimate material strength) for the hoist load bearing components.

The 200 ton main hoist is equipped with two holding brakes and an emergency drum brake. The hoist is reeved with two wire ropes, each capable of holding the load up to the crane's rated capacity.

The cranes were one-time proofloaded at 125 percent of rated capacity, are load tested annually at 100 percent of rated capacity, and have a monthly, quarterly, semiannual and annual preventive maintenance program to ensure proper operation.

The wire rope is inspected monthly for discrepancies. Non-Destructive Testing (NDT) of the crane hook is performed annually.

The H77-0384-1 segment lifting beam was one-time proofloaded to 740,000 +/- 74,000 pounds and is load tested annually to 462,000 +/- 10,000 pounds. The beam also undergoes semiannual preventive maintenance and an annual NDT for load bearing members and critical welds.

The lifting beam is designed to a 5 to 1 safety factor for failure and 3 to 1 for yield. The design safe working load of the H77-0384-1 lifting beam is 370,000



**NASA SUSPENDED LOAD OPERATION  
ANALYSIS/APPROVAL (SLOAA)**

**SLO-KSC-1991-012  
CHANGE 1, FEBRUARY 1999  
PAGE 4 OF 5**

pounds. The heaviest flight component lifted is the aft booster which weighs approximately 350,000 pounds.

The H77-0388 segment lifting beam was one-time proofloaded to 720,000 +/- 64,000 pounds. The beam also undergoes an annual NDT for load bearing members and critical welds and the pins are dye penetrant inspected annually. The H77-0388 lifting beam is designed to a 5 to 1 safety factor for failure and 3 to 1 for yield.

**Alternate Standard Requirement #7:** A Systems Assurance Analysis (SAA) has been completed on the RPSF 200 ton bridge cranes. The SAA includes a Failure Mode and Effects Analysis/Critical Items List (FMEA/CIL) and a Hazards Analysis. No single failure points were identified.

**Alternate Standard Requirement #8:** The 200 ton bridge cranes undergo a visual inspection and pre-operational checkout prior to each use per NSS/GO-1740.9.

**Alternate Standard Requirement #9:** A trained, licensed and certified operator will remain at the controls while personnel are under a suspended load. In addition, a qualified Emergency Stop operator is stationed in the vicinity of personnel working under the suspended load. All personnel responsible for the direction and/or performance of the operation undergo training that meets or exceeds the required certifications per NSS/GO-1740.9.

**Alternate Standard Requirement #10:** Control areas are established per OMI B5143. For aft booster lifting operations, a control area is established in the transfer aisle along the path of travel. Only essential personnel are allowed in the control area. A second, smaller control area is established under a suspended load.

Control areas are established using rope, amber lights, and placards to ensure non-essential personnel are kept out of the area. For operations under a suspended load, a badge board is maintained in the immediate area. Only those personnel badged and with the approval of the Task Leader are allowed under the load.

**Alternate Standard Requirement #11:** Pre-operational briefings are held by the Task Leader and all essential personnel involved with the operation. Shift change pre-operational briefings are held if operations are to occur on multiple shifts.



NASA SUSPENDED LOAD OPERATION  
ANALYSIS/APPROVAL (SLOAA)

SLO-KSC-1991-012  
CHANGE 1, FEBRUARY 1999  
PAGE 5 OF 5

**Alternate Standard Requirement #12:** Communications (by voice, radio and visual) are maintained with all personnel under a suspended load. Emergency procedures contain instructions and personnel are trained to discontinue operations if communications are lost. The hardware is safed and the area is cleared if additional hazards warrant clearing the control area. All personnel are cleared from under a suspended load during loss of communications.

**Alternate Standard Requirement #13:** All personnel remain within sight of the Lift Coordinator and the Emergency Stop operator.

**Alternate Standard Requirement #14:** The Center NASA Safety Assurance Directorate shall conduct periodic reviews to ensure the continued safety of suspended load procedures.

**Alternate Standard Requirement #15:** The Center NASA Safety Assurance Directorate will provide copies of approved SLOAAs, a list of approved suspended load operations, a list of cranes/hoists used for suspended load operations and copies of the associated FMEA/CIL and hazards analyses to NASA Headquarters.

APPROVAL:

DATE:

Malcolm Kern for 4/28/99

Bruce L. Jansen

Acting Director, Safety Assurance

Kennedy Space Center